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Memo

To:	Andre Lauzon
Cc:	David Krizek
From:	Clarissa Barraza
Department:	Environmental
Date:	01Sept2021
Subject:	Using fugitive limestone silt from Imerys limestone quarry to extrapolate the potential range of transport from the Rosemont Copper World Project site via ephemeral washes.

SUMMARY

One of the key parameters in determining whether the ephemeral washes on Rosemont Copper World Project (Project) site's private land are considered jurisdictional under the Clean Water Act is to demonstrate connectivity. Specifically, the transport of chemical elements or compounds from headwaters (washes) such that:

1. The flow events in the wash that are likely to reach a traditional navigable water of the US and
2. Be of such volume or concentration that it affects the waters of the US chemically and biologically.

Rain events in this region are episodic, of varying duration and volumes. Thus, it is appropriate to evaluate the transport distance of the uncontrolled limestone fugitive from the Imerys site as it has experienced a range of rain events during its 50 years of operation.

This study quantitatively assesses the conveyance of the limestone powder down the ephemeral wash from its source, the Imerys mine. The Imerys quarry is directly adjacent to the Project and shares the same washes draining the area during storm event. Drainages from the area eventually discharge into the Santa Cruz River. Analysis of aerial photography combined with ground surveys indicate that the maximum reach of fugitive limestone from the Imeyrs quarry (either through suspended particles or soluble solution) is approximately 7 miles downstream (see figure xx).

Additionally, potential contaminate sources from the Project could be sulphide or oxide particles in granular form that may be transported down the ephemeral washes during storm events. Those particles by their chemical nature are deemed denser than the limestone silt and are therefore expected to travel shorter distances than the measured limestone silt granules. Another mode of transport of these potential contaminates is in solution where the contaminants travel until PH conditions change thereby causing precipitation or flowing until the flow stops and precipitate occurs due to evaporation.

The evaporated residue, calcite, accumulation was analyzed microscopically to determine if

1. The residual calcite marker noted in the washes were silty granules settled in drying puddles or
2. Crystalline in nature thus reflecting calcium in solution precipitating as water dried up in the furthest reaches of the water flows.

In summary, the presence of silty granules would indicate the maximum distance that the water could carry particles lighter (less dense) than expected from the Project deposits. Additionally, in the case of precipitates distinct to Imerys, it would indicate the maximum distance water travelled from the origin which could potentially host contaminants from the Project in aqueous form. In either case, the unique characteristics and purity of the Imerys quarry limestone silt serves as an ideal marker for tracing transport from storm flow events over the quarry's 50year history.

DESCRIPTION

Imerys Mine is a marble-limestone quarry located 15 miles southeast of Sahuarita and located northwest of the Rosemont Copper World Project. Imerys operations which have owned the mine since 1997 produces limestone for distribution. This area has been mined for limestone since 1972; previously owned by Homestake Productions. The limestone (primarily calcium carbonate) residue can be seen throughout the area as a white powder that is carried downstream in the ephemeral washes during intermittent storm flows.

One method of conveying calcium carbonate is through the suspension of limestone powder in water in storm flows. The bulk density of pulverized limestone is 68 lb/ft^3. As compared to water (62.4 lb/ft^3) the powder has a specific gravity of 1.1 and as such will be suspended in water. Typically for fine solids the minimum flow velocity needed for suspension is 3-5 ft/s. Thus, during the intermittent storm flow and with its specific gravity, the powder will flow down the wash until the velocity is under 3ft/s at which point the residue will drop and leave the white/lighter markings.

(Insert photos of powder)

The solubility properties of calcium carbonate also contribute to the conveyance and deposition of this residue. The chemical properties of calcium carbonate indicate that in pure water it has a very low solubility but increases in rainwater due to the formation of more soluble calcium bicarbonate. Rainwater is weakly acidic, and when added to limestone some of the calcium carbonate reacts to form the calcium bicarbonate solution. As the water evaporates it leaves behind a calcium carbonate deposit.

(Insert photos of crystals if found)

This study uses the fine limestone powder residue as a visual indicator of the process of physically moving particles through the drainages (washes). The limestone produces a white or lighter color on google earth imagery and can be distinguished from those washes that do not carry limestone powder. The images below are photos taken at different points and compared to the google imagery in that same area.

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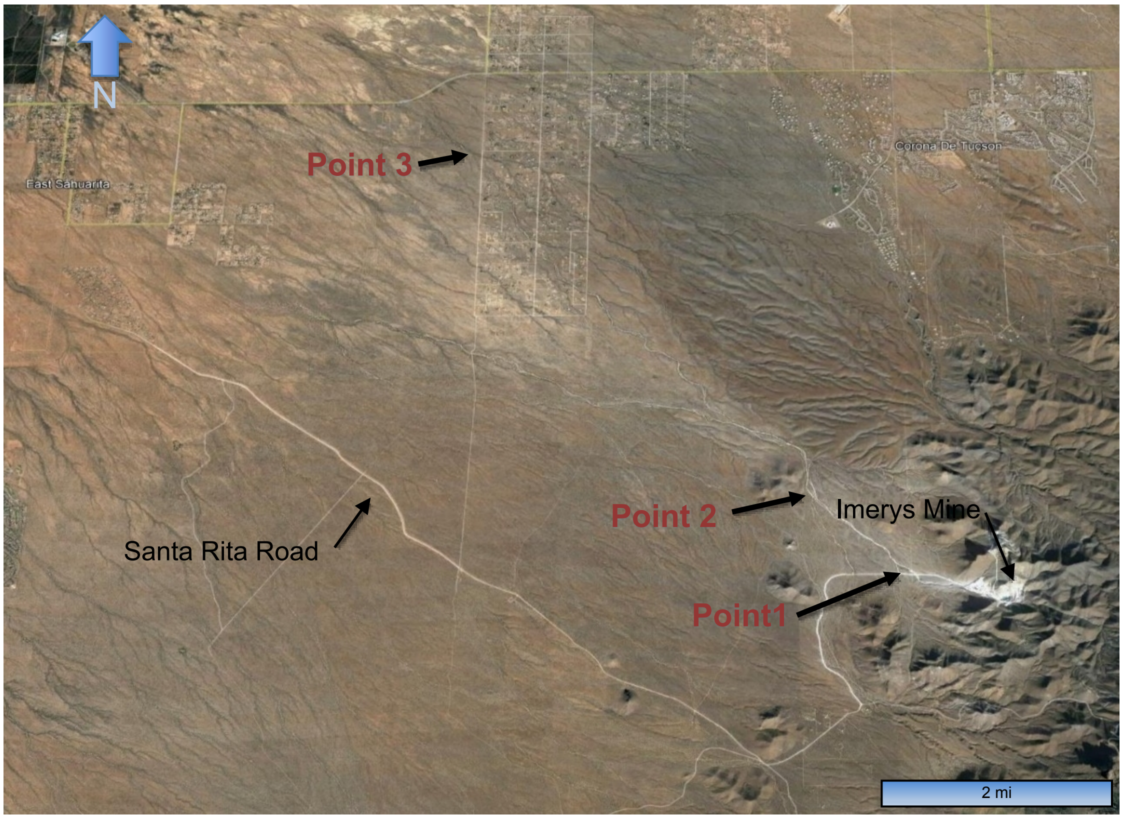


Point A1

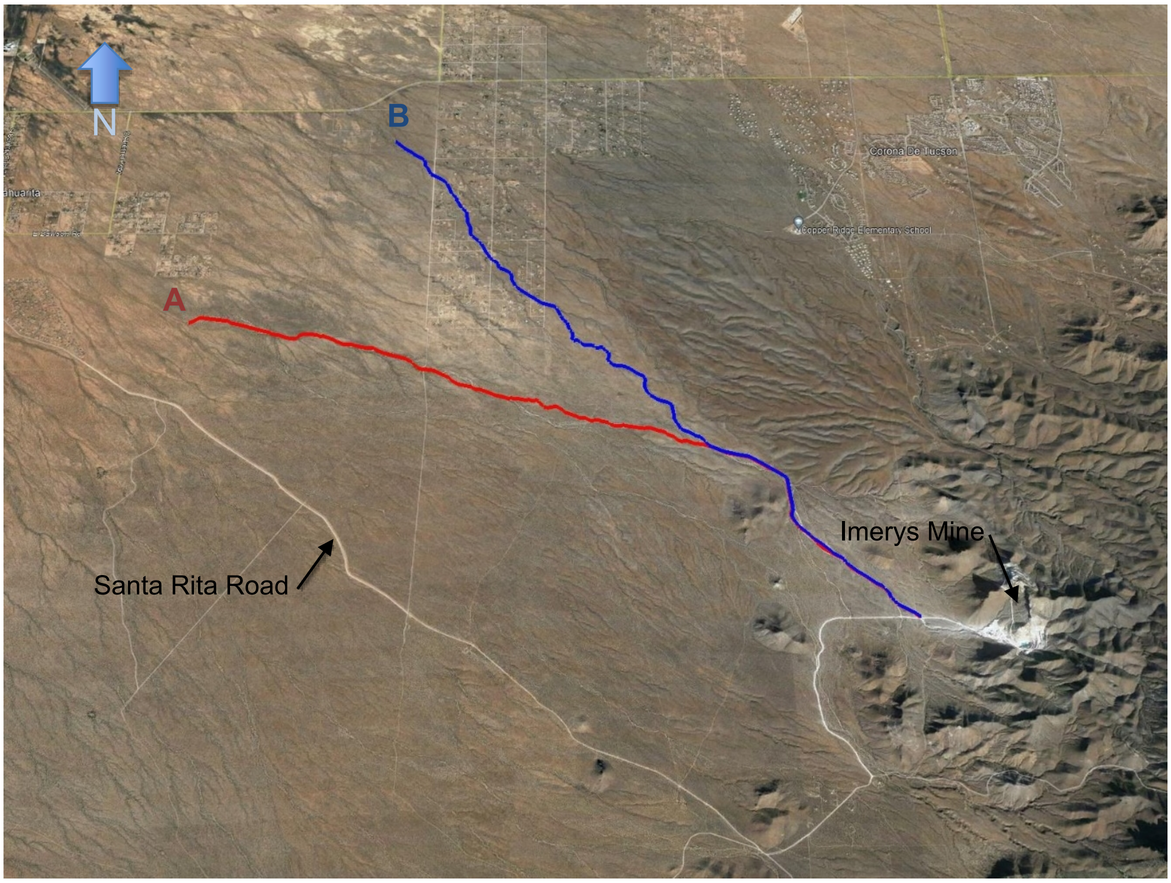
RCC-CW017819

Point A2

Point B1

RCC-CW017820

From the study, the limestone reaches a downstream wash at approximately 7 miles from the source. Two different paths (A and B) have been taken as the washes diverge with a carrying distance of 7.54 miles, and 7.38 miles for A and B respectively.



FIGURES

The subsequent figures are captures from Google Earth Imagery Date of 12/18/2020. These images of the washes are used at different points throughout the path to demonstrate in more detail the deposited limestone. As stated, the intermittent wash flows the limestone powder travels and the deposits leaves a white trail that can be visually traced. This residue slowly fades the further it moves from the source. At about 7 miles downgradient from the Imerys mine, the residue becomes visually unremarkable.

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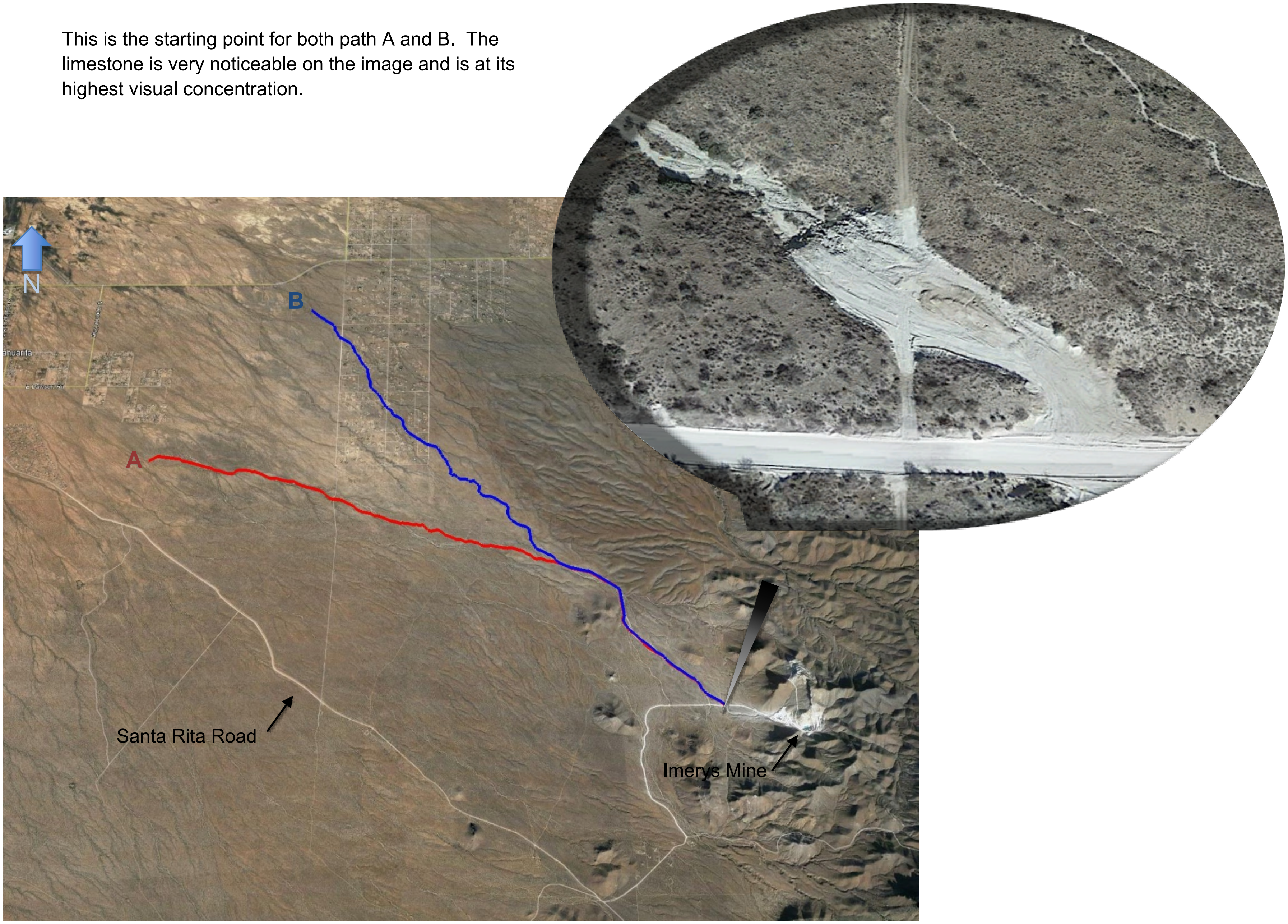
This is the starting point for both path A and B. The limestone is very noticeable on the image and is at its highest visual concentration.



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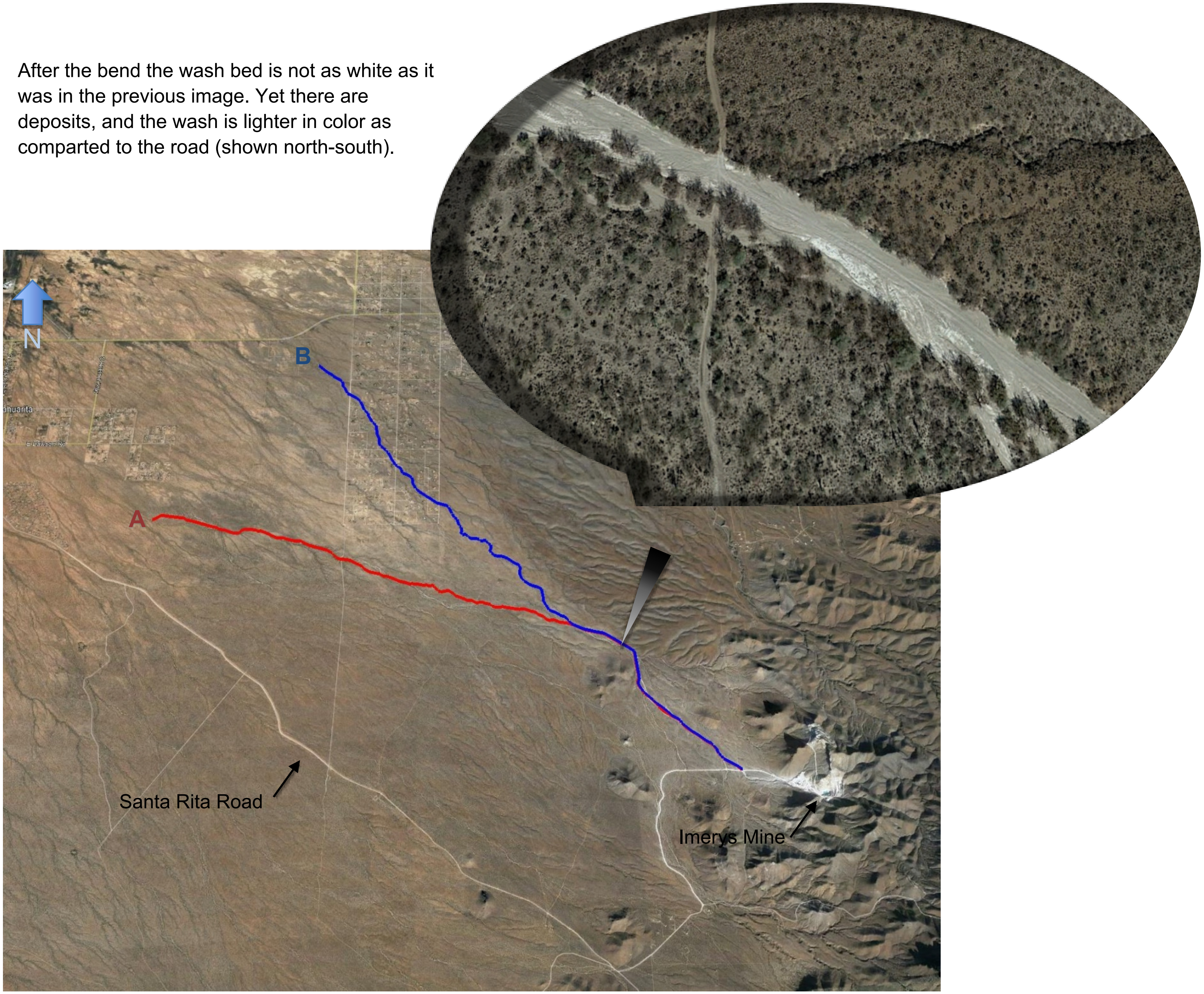
After the bend the wash bed is not as white as it was in the previous image. Yet there are deposits, and the wash is lighter in color as comparted to the road (shown north-south).



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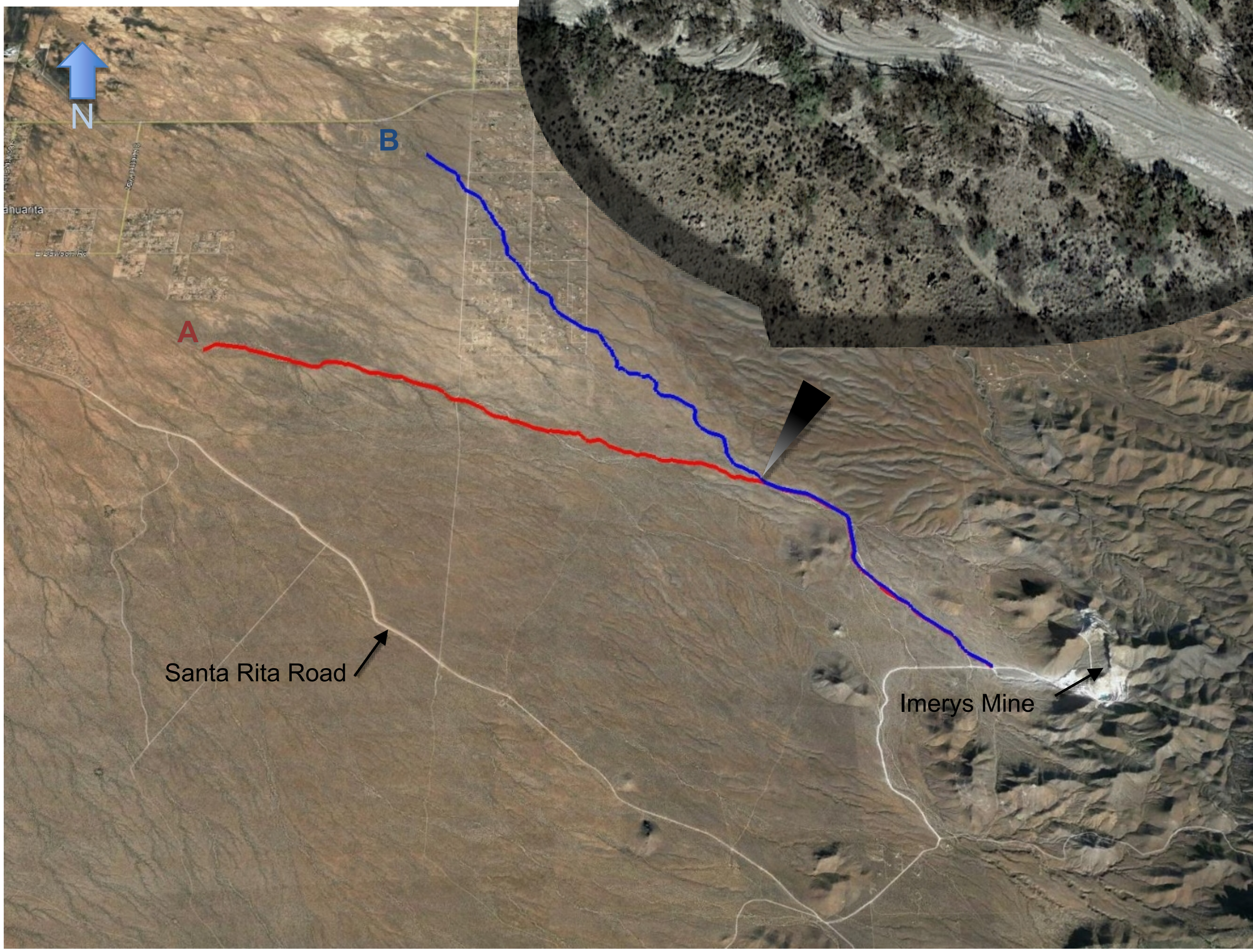
The divergence between Path A and B is shown and deposits of limestone silt are visible as white patches. The wash bed is still lighter than the surrounding area.



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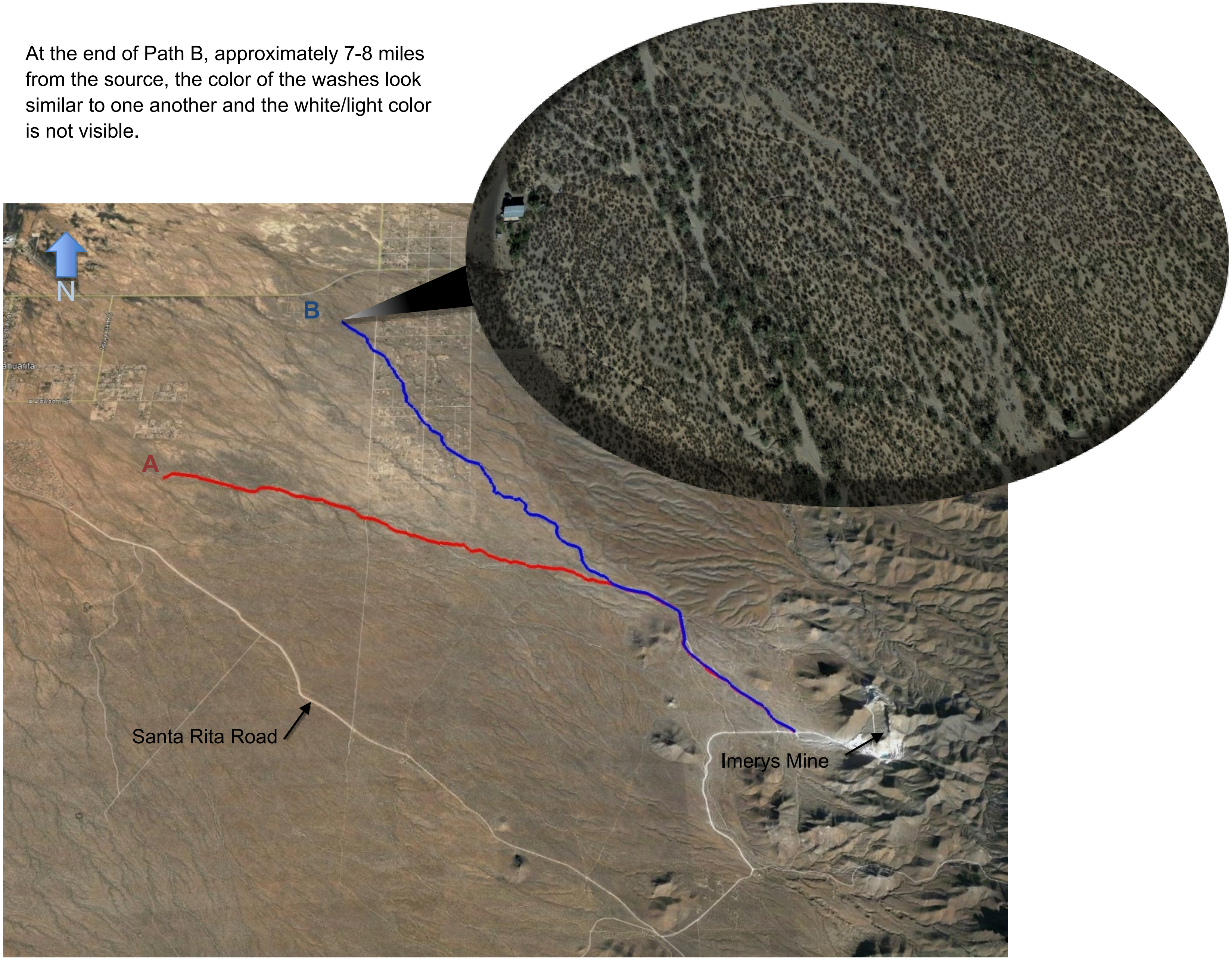
At the end of Path B, approximately 7-8 miles from the source, the color of the washes look similar to one another and the white/light color is not visible.



RCC-CW017825

At the end of Path A, as with Path B, and approximately 7-8 miles from the source the color of the washes look similar to one another as well.